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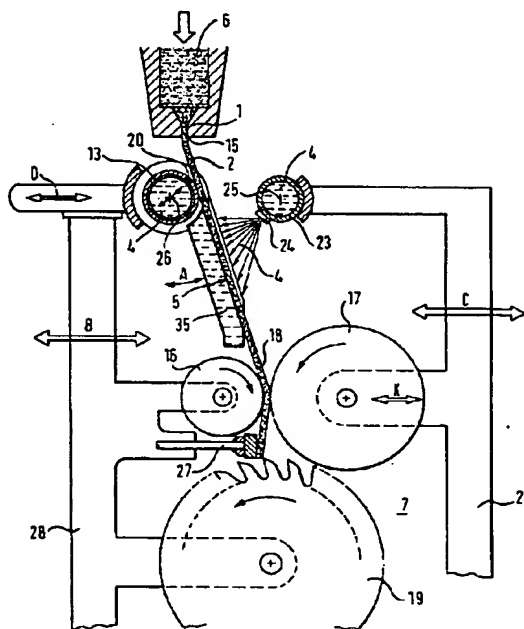
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(54) PROCEDE ET DISPOSITIF PERMETTANT D'AMENER ET DE TRAITER DES BOUDINS EN PLASTIQUE
(54) METHOD AND DEVICE FOR FEEDING AND TREATING PLASTIC STRANDS

(57)

The invention relates to a method for feeding and treating plastic strands that are discharged from nozzles in a molten state by means of a cooling section in order to granulate the plastic strands. According to the invention, the plastic strands are partially crystallized in a temperature-adjusted liquid medium in a crystallization section once they are discharged from the nozzles, the liquid medium being maintained at a temperature above the glass transition temperature of the plastic strands. The invention further relates to a device for carrying out said method. The inventive device comprises a plastic melting device, a device for extruding the strands from nozzles, a crystallization section that is located directly downstream of the nozzles, and a granulation device that is located downstream of the crystallization section. The temperature of the crystallization section is adjusted by means of heating and/or cooling devices and is provided with temperature adjusting elements with which the temperature of the temperature-adjusted liquid medium can be adjusted to a temperature above the glass transition temperature of the plastic strands.



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Rieter Automatik GmbH

Munich, 16 July 1999

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Abstract

The invention relates to a method for feeding and treating plastic extrudates which emerge from dies in the form of a molten liquid, having a cooling zone for pelletizing the plastic extrudates, the plastic extrudates, immediately after they leave the dies, being partially crystallized in a temperature-controlled liquid medium over a crystallization zone, the liquid medium being held at a temperature which is above the glass transition temperature of the plastic extrudates. The invention furthermore relates to an apparatus for carrying out the method, the apparatus having a plastic-melting apparatus, an apparatus for extruding from dies, a crystallization zone part, which is arranged immediately downstream of the dies, and a pelletizing apparatus which is arranged downstream of the crystallization zone part. To control the temperature of the crystallization zone, the apparatus has heating and/or cooling devices, and temperature-control units, by means of which the temperature of the temperature-controlled liquid medium can be set to a temperature which is above the glass transition temperature of the plastic extrudates.

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Method and apparatus for feeding and treating plastic extrudates

5 The invention relates to a method and an
apparatus for feeding and treating plastic extrudates
which emerge from dies in the form of a molten liquid,
having a cooling zone for pelletizing the plastic
extrudates, in accordance with the preambles of Claims
10 1 and 11.

A method of this type is known from document
DE 43 14 162. In this method, which is known from the
prior art, the plastic extrudates are only pelletized
once the plastic extrudates have been quenched in cold
15 water and then drained, dried and crystallized, for
which purpose a device which generates a flow of
cooling liquid is integrated in an outlet channel for
quenching the plastic extrudates emerging from a die.
Following a quenching zone of this nature, there comes
20 a draining zone in which the cooling liquid is allowed
to run freely out of the outlet channel, followed by a
drying zone, in which blow nozzles blow the residual
adhering cooling liquid off the plastic extrudates, the
dried plastic extrudates crystallizing fully in an
25 adjoining elongate drying zone, before subsequently
being pelletized by means of a pelletizer. To carry out
the method according to the prior art, an elongate
running channel which is several meters long is
required, in order to ensure that the different
30 residence times in the quenching zone, the draining
zone and the drying zone for crystallization of the
plastic extrudates are achieved.

A known apparatus of this type has the drawback
that to carry out the method a high outlay on apparatus
35 is required, in particular because of the relatively
long outlet channel in which the different phases from

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dried plastic extrudates have to take place before pelletizing can be carried out. Other known methods pelletize the extrudates in the non-crystalline amorphous state, which is reached by firstly cooling
5 the plastic extrudates in a coolant to below the glass transition temperature, so that then they can be processed into pellets after the amorphous state has been reached under the influence of the coolant and in the presence of the coolant. For this "underwater
10 pelletizing method", the cooling zone is considerably longer than a quenching zone in the outlet channel, in order to pelletize the plastic extrudate using a cooling medium, which is usually cold water, in order to maintain the amorphous state as is also present in
15 the molten plastic.

To carry out both methods which are known from the prior art, complex, elongate outlet channels are required which, although they do ensure exact and reproducible production of the pellets in crystalline
20 or amorphous form, take up large amounts of space due to their length and the fact that their components have to be adapted to one another.

The object of the invention is to specify a method for feeding and treating plastic extrudates
25 which emerge from dies in the form of a molten liquid, having a cooling zone for pelletizing the plastic extrudates, which method can make do with significantly shorter extrudate lengths prior to pelletization and is therefore suitable for apparatus which take up little
30 space.

This object is achieved by means of the subject matter of Claims 1 and 11. Features of preferred embodiment of the invention are disclosed in the associated sub-claims.

35 To shorten the residence time in an outlet channel, the plastic extrudates are partially crystallized directly after they emerge from the dies, by means of a liquid temperature-controlled medium, for which purpose the liquid temperature is controlled.

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is held at a temperature which is above the glass transition temperature of the plastic extrudates.

This method has the advantage that the plastic extrudates which emerge from the dies in the form of a molten liquid are not quenched with cold water, in order then to be dried, crystallized and pelletized, but rather the plastic extrudates enter a relatively hot, liquid medium, the temperature of which is well controlled, thus ensuring that the temperature of the plastic extrudates does not fall below the glass transition temperature throughout an outlet channel for the plastic extrudates. As a result, partial crystallization at least in the surface region of the plastic extrudates occurs, so that the plastic extrudates become sufficiently strong to then be broken down into pellets in the pelletizing installation without prior drying of the plastic extrudates. Immediately downstream of the pelletizing device there is a mixture of pellets and liquid cooling medium, from which the pellets can be separated using known means. Since the partial crystallization at least of the surface of the plastic extrudates begins immediately after the molten plastic has emerged from the dies, the plastic extrudates can be pelletized after they have passed through a relatively short temperature-control zone.

Preferably, the length of the zone in which the plastic extrudates are held under temperature-controlled liquid medium is designed for residence times of longer than 0.5 second and shorter than 5 seconds. For this purpose, the temperature of the liquid medium is preferably controlled in such a way that a constant temperature which is above the glass transition temperature is maintained in the liquid medium. This holding of the temperature preferably takes place in a circuit for the liquid medium, in which appropriately controlled heating elements are used in the heating circuit. In this way, the

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a manner that the temperature of the medium is below 150% of the glass transition temperature in °C and above 100% of the glass transition temperature in °C for the plastic extrudate. In a preferred configuration of the method, the liquid medium used is hot water. This has the advantage over methods which use cold-water quenching or cold-water cooling that there can be no problems with algae formation in the hot-water circuit, since these algae do not survive in the hot water. Furthermore, water has the advantage over other liquids that it can be prepared as ultrapure water relatively inexpensively, so that the costs of the overall method can be kept relatively low.

In a further preferred configuration of the method, the plastic has a glass transition temperature of below 100°C. Plastics with such a low glass transition temperature have the advantage that hot water can be used as the temperature-controlled liquid medium. At temperatures above 100°C, it is preferably possible to use glycerol/water mixtures or oils as the temperature-controlled liquid media.

In a further preferred embodiment, the molten plastic contains polyamides. With polyamides of this type, which contain an NH group as the amino group, there are two plastics with entirely different glass transition temperatures. One of these plastics is polymerized by the addition of lactam to form polyamide-6 and has a glass transition temperature of between 40 and 60°C. For a plastic of this type, hot water is advantageous as the temperature-controlled liquid medium, since the deposits of lactam are lower in hot water than in cold water circuits, due to the higher solubility of lactam, and therefore there is less risk of contamination to the circuit. Furthermore, the present method yields significantly hotter partially crystallized pellets compared to the amorphous pellets produced hitherto under cold water. These hotter pellets require shorter heating times during subsequent processing.

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and therefore reduce the energy consumption of the overall method.

5 A second group of polyamides is formed by polycondensation of two different monomers, such as the diamine and the dicarboxylic acid, which under condensation conditions form a polyamide-6.6 which has a glass transition temperature which is about 10°C higher, lying between 50°C and 80°C.

10 In another preferred embodiment of the method, a plastic is processed wherein the molten plastic contains polyolefins. Molten plastics of this nature can likewise be processed into plastic extrudates by emerging from dies and can therefore be partially crystallized immediately after they leave the dies, according to the invention, in a heat-controlled liquid medium over a crystallization zone.

15 In a further preferred embodiment of the method, the plastic extrudates pass through a substantially vertical crystallization zone. A substantially vertical crystallization zone of this nature has the advantage that there is no need to take any special measures for guiding the crystallization extrudates towards the pelletizer, particularly if the plastic extrudates are guided over the crystallization zone by dropping freely.

20 An apparatus for feeding and treating plastic extrudates which emerge from dies in the form of a molten liquid has a crystallization zone part which is arranged immediately downstream of the dies, heating and cooling devices preferably being provided for the crystallization zone, and a temperature-control unit, by means of which the temperature of a temperature-controlled liquid medium can be set to a temperature which is above the glass transition temperature of the plastic, is provided. For this purpose, the crystallization zone part is preferably arranged substantially vertically.

25 Preferably, the temperature-controlled liquid medium is set to a temperature which is above the glass transition temperature of the plastic.

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means of through-flow thermostats as the heating and cooling device, which hold the temperature-controlled liquid medium at a constant initial temperature which is above the glass transition temperature and is up to
5 150% of the glass transition temperature.

In a preferred embodiment of the apparatus, the pelletizing apparatus 7 is arranged immediately after the crystallization zone part 35, downstream of the crystallization zone 5 as seen in the direction of flow
10 of the material. For this purpose, the crystallization zone part may be an integral component of the pelletizing device. In order to be able to start up a contact device of this nature, comprising crystallization zone and pelletizing device, a device
15 of this nature can be separated in such a way that initially, for stabilization purposes, the plastic extrudates emerging from the dies can drop freely downwards. After an automatic extrudate-cutting device has come into action, the separate parts of the device
20 are moved together, so that stabilized plastic extrudates can at least partially crystallize immediately in the area of the crystallization zone part and can be processed into a mixture of pellets and medium in the connected pelletizing device.

25 To control the temperature of the underside of the plastic extrudates emerging from the dies, a feedpipe is preferably arranged downstream of the dies. This feedpipe carries the temperature-controlled liquid medium in its interior and guides the plastic
30 extrudates on its outer surface. To supply the crystallization zone part with temperature-controlled medium, the feedpipe has a longitudinal slot which is positioned in such a way that it supplies the underside of the plastic extrudates with temperature-controlled
35 liquid medium, by forming a film of temperature-controlled liquid medium on the crystallization zone part. The temperature of the top side of the plastic extrudates is controlled in the

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nozzles which are supplied with temperature-controlled liquid medium from a further feed pipe.

5 In a further preferred embodiment of the apparatus, the feedpipe which guides the plastic extrudates may, instead of having a longitudinal slot at each position for guiding a plastic extrudate, have a hole for controlling the temperature of the underside of the plastic extrudate by means of a temperature-controlled medium.

10 In a preferred alternative embodiment of the apparatus, the crystallization zone part can pivot between an at-rest position and a working position, the at-rest position allowing the molten plastic to emerge from the dies in the vertical direction, and the
15 working position feeding the plastic extrudates to a pelletizing device in partially crystallized form. This embodiment has the advantage that, despite a space-saving arrangement, the pelletizing device as an individual component may adopt a fixed position, while
20 only the crystallization zone part is designed moveably or pivotably. The transition from the crystallization zone part to the pelletizing device can be ensured by means of a short feed channel which preferably projects out of the pelletizing unit.

25 Further advantages, features and possible applications of the invention will now be explained in more detail on the basis of an exemplary embodiment and with reference to the appended drawings, in which:

30 Fig. 1 shows an outline sketch of an apparatus for carrying out the method according to one embodiment of the present invention,

Fig. 2 shows an outline sketch of an apparatus including a circuit for heat-controlled liquid medium according to a further embodiment of the
35 present invention,

Figs. 3 and 3B show cross-sectional views, in the longitudinal direction and perpendicular thereto, of a feedpipe leading to the crystallization zone part.

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conveys a temperature-controlled and liquid medium and on the outside guides plastic extrudates, and

5 Figs. 4A and 4B show cross-sectional views, in the longitudinal direction and perpendicular thereto, of a feedpipe leading to the crystallization zone, which on the inside carries a temperature-controlled liquid medium and on the outside guides plastic extrudates.

10 Figure 1 shows an outline sketch of an apparatus for carrying out the method for feeding and treating plastic extrudates 2 which emerge from dies 1 in the form of a molten liquid, having a cooling zone, for pelletizing the plastic extrudates 2, having a
15 crystallization zone 5, for pelletizing the plastic extrudates 2, according to one embodiment of the present invention. Immediately after they emerge from the dies 1, the plastic extrudates 2 are partially crystallized in a temperature-controlled liquid medium
20 4 over a crystallization zone 5. For this purpose, the liquid medium 4 is held at a temperature which is above the glass transition temperature of the plastic extrudates 2 and is not quenched to below the glass transition temperature, let alone cooled 2 and held
25 below the glass transition temperature in a long guide channel under cooling water, as is conventional in the prior art, in order to feed the plastic extrudates 2 to a pelletizing device in an amorphous state. Since in the method according to the invention partial
30 crystallization is achieved by means of a temperature-controlled liquid medium 4 immediately after the extrudates emerge from the dies 1, the crystallization zone is extremely short, and therefore the distance between the pelletizing device and the die
35 exit 15 is extremely short.

In a preferred apparatus for carrying out the method, as shown in Figure 1, the crystallization zone 5 is therefore an integral component of the immediately

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roller 16 and a pressure-exerting roller 17, which may be driven synchronously with the drive roller 16, the pelletizing device picks up the partially crystallized plastic extrudates 18 and feeds them to the cutting
5 rotor 19, so that a mixture of temperature-controlled liquid medium and plastic pellets is formed in the pelletizing device 7, and this mixture can be fed for further processing.

To control the temperature of the plastic
10 extrudates which are to be crystallized by means of a temperature-controlled liquid medium 4, the apparatus as shown in Figure 1 has a feedpipe 13, which is explained in more detail below in conjunction with Figures 3A, 3B or 4A and 4B.

15 This feedpipe 13 leading to the crystallization zone 5 has an elongate slot 20, which makes it possible for the temperature-controlling liquid medium 4 to form a temperature-controlling film of liquid in the area of the crystallization zone 5. The longitudinal slot 20
20 may also be replaced by a series of holes, so that the temperature-controlling liquid medium 4 emerges from the feedpipe 13 directly at those positions at which a plastic extrudate 2 is in each case introduced. To guide the plastic extrudates 2, the feedpipe has a
25 structured shell on its outer circumference, in the longitudinal direction, which has circumferential channels 22, as shown in Figure 3A, or circumferential grooves 21, as shown in Figure 4A. These circumferential grooves 21 or circumferential channels
30 22 on the feedpipe 13 serve to guide the plastic extrudates towards the crystallization zone 5.

While the feedpipe 13 supplies the temperature-controlling liquid medium from one side of the plastic extrudates, referred to below as the
35 underside, via its longitudinal slot 20 or its corresponding holes, the temperature of the other side of the plastic extrudates, referred to below as the top side, is in this embodiment of a device for carrying

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using temperature-controlled liquid medium coming out of spray nozzles 24. The spray nozzles 24 are supplied with temperature-controlling liquid medium 4 via a further feedline 23. The spray angle of the spray nozzles 24 can be adjusted by pivoting the feedpipe 23 about its axis 25. The angle at which the plastic extrudates 2 slide over the crystallization zone can be adjusted by pivoting the feedpipe 13 about its axis 26, since in this preferred apparatus a crystallization zone part 35 and the feedpipe 13 are fixedly connected to one another. In other embodiments, the angle of inclination of the crystallization zone 5 may also be adjusted independently of the position of the feedpipe 13.

15 In the integral embodiment shown in Figure 1, with the pelletizing device 7 and crystallization zone part 35 in a compact assembly, the feedpipe 13, the drive roller 16 and the cutting roller 19 with the cutting-edge support 27 are arranged on a frame, and 20 the entire frame 28 can be displaced in the direction of arrow B, while a second frame 29, on which the feedline 23 and the pressure-exerting roller 17 are arranged, can be displaced in the direction of the arrow C. As a result of the frame being divided into 25 two parts in this way, it is easier to start up the apparatus, in that the frames 28 and 29 are only moved together when the formation of plastic extrudates at the die exit 15 has stabilized. On the other hand, during the start-up phase the feedpipe 13 may be 30 displaced in direction D with respect to the frame 28, in order to align the feedpipe 13 towards the die head 6.

Figure 2 shows an outline sketch of an apparatus for carrying out the method, including a 35 circuit for a temperature-controlled liquid medium, according to a further embodiment of the present invention. This embodiment shown in Figure 2 differs from the embodiment shown in Figure 1 through the fact

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extrudates 2 is controlled by means of a large-area spraying device 30 with a multiplicity of spray nozzles 24. Furthermore, in this embodiment the pelletizing device 7 is not displaceable, but rather is fixedly connected to a bottom crystallization zone part 47. A top crystallization zone part 46 can pivot, together with the feedpipe 13, about the joint 45, in direction F, in order to make it easier to start up the installation.

After a stable state has been reached at the die exit, the plastic extrudates 2 can be cut to length by means of an automated extrudate-cutting device (not shown), and the top crystallization zone part 46 can be pivoted in, and with the aid of the crystallization zone 5 partial crystallization of the extrudates can be achieved prior to pelletizing. For this purpose, the temperature of the undersides of the crystallization extrudates 2 is controlled using temperature-controlled liquid medium 4 from the feedline 13, via the longitudinal slot 20 or corresponding holes 40, and the top side of the extrudates is supplied with temperature-controlled liquid medium 4 by the large-area spraying device 30.

The partially crystallized extrudates are fed to the pelletizing device 7 via the feed channel 31, pelletizing taking place under a liquid medium. The mixture of liquid medium 4 and pellets 12 is fed to a separator 12, which feeds pellets 12 which have been separated from the liquid medium for further processing in the direction of arrow G and feeds the liquid medium to a temperature-control unit 9. In this temperature-control unit, the temperature of the liquid medium is controlled by means of heating and/or cooling devices 8 and this medium is fed to the large-area spraying device 30, the feedpipe 13 and the pelletizing device. In this embodiment, which is intended to process PA6 plastic extrudates, the coolant is a hot water, the temperature of which has been set to 80°C.

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Figure 3A and Figure 3B show cross-sectional views in the longitudinal direction (Figure 3A) and perpendicular thereto (Figure 3B) through a feedpipe 13 leading to the crystallization zone, which pipe, on the inside, carries a temperature-controlled cooling medium 4 and, on the outside, guides plastic extrudates in circumferential rings 33. For this purpose, the feedpipe 13 is coated with an outer layer 32 of good thermal conductivity, for example a layer of a metal alloy, in which circumferential channels 22 are formed. In this embodiment, the feedpipe 13 has a longitudinal slot 20 through which temperature-controlled liquid medium 4 can emerge in the direction of arrow L, and can cover a crystallization zone 5 on a crystallization zone part 35 with a film of temperature-controlled liquid.

Figures 4A and 4B show cross-sectional views in the longitudinal direction and perpendicular thereto of a feedpipe 13 leading to the crystallization zone, which on the inside carries temperature-controlled liquid medium 4 and on the outside guides plastic extrudates in circumferential grooves 21. The circumferential grooves 21 differ from the circumferential channels 22 shown in Figure 3A in that they are formed in sawtooth form in an outer layer 32. Furthermore, at the position of each extrudate, holes 40 are provided in order to allow liquid medium 4 to emerge from the feedpipe 13 in the direction of arrow M, so that the temperature of the plastic extrudates 2 can be controlled on their underside by means of the medium 4.

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Rieter Automatik GmbH

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New Patent Claims

1. Method for feeding and treating plastic
5 extrudates (2) which emerge from dies (1) in the form
of a molten liquid, having a cooling zone for
pelletizing the plastic extrudates (2), characterized
in that the plastic extrudates (2), immediately after
they leave the dies (1), are partially crystallized in
10 a temperature-controlled liquid medium (4) over a
crystallization zone (5), the liquid medium (4) being
held at a temperature which is above the glass
transition temperature of the plastic extrudates (2)
until the subsequent pelletization stage.
- 15 2. Method according to Claim 1, characterized in
that the temperature of the liquid medium (4) is
controlled in such a manner that a constant temperature
which is above the glass transition temperature is
maintained in the liquid medium (4).
- 20 3. Method according to Claim 1 or 2, characterized
in that the temperature of the liquid medium (4) is
controlled in such a manner that the temperature of the
medium is below 150% of the glass transition
temperature in °C and above 100% of the glass
25 transition temperature in °C.
4. Method according to one of the preceding
claims, characterized in that the liquid medium (4)
used is hot water.
5. Method according to one of the preceding
30 claims, characterized in that the plastic extrudates
(2) have a glass transition temperature of below 100°C.
6. Method according to one of the preceding
claims, characterized in that the molten plastic (6)
contains polyamides.
- 35 7. Method according to one of the preceding
claims, characterized in that the molten plastic (6)

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8. Method according to one of the preceding claims, characterized in that the temperature of the plastic extrudates (2) is controlled as they pass through a substantially vertical crystallization zone (5).

9. Method according to one of the preceding claims, characterized in that the plastic extrudates (2) are guided in the crystallization zone (5) by dropping freely.

10. Method according to one of the preceding claims, characterized in that the plastic extrudates (2) are fed to a pelletizing device (7) for further treatment.

11. Apparatus for feeding and treating plastic extrudates, having dies (1), from which the plastic extrudates emerge in the form of a molten liquid, having a cooling zone part, which is arranged immediately downstream of the dies (1), and having a pelletizing apparatus (7) which is arranged downstream of the cooling zone part, characterized in that the cooling zone part is designed as a crystallization zone part (35) and, to control the temperature of the crystallization zone (5) of the crystallization zone part (35), heating and/or cooling devices (8) and temperature-control units (9) are provided, by means of which the temperature of a temperature-controlled liquid medium (4) can be set to a temperature which is above the glass transition temperature of the plastic extrudates (2).

12. Apparatus according to Claim 11, characterized in that the crystallization zone part (35) is arranged substantially vertically.

13. Apparatus according to Claim 11 or 12, characterized in that the heating and cooling devices (8) are through-flow thermostats which set the temperature-controlled liquid medium (4) to a constant initial temperature.

14. Apparatus according to one of Claims 11 to 13, characterized in that the liquid medium (4) is a water-glycol mixture.

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arranged immediately after the crystallization zone part (35), downstream of the crystallization zone (5) as seen in the direction of flow of the material.

15. Apparatus according to one of Claims 11 to 14, characterized in that a feedpipe (13), in order to control the temperature of the underside of the plastic extrudates (2), conveys the temperature-controlled liquid medium (4) in its interior and guides the plastic extrudates (2) on its outer surface.

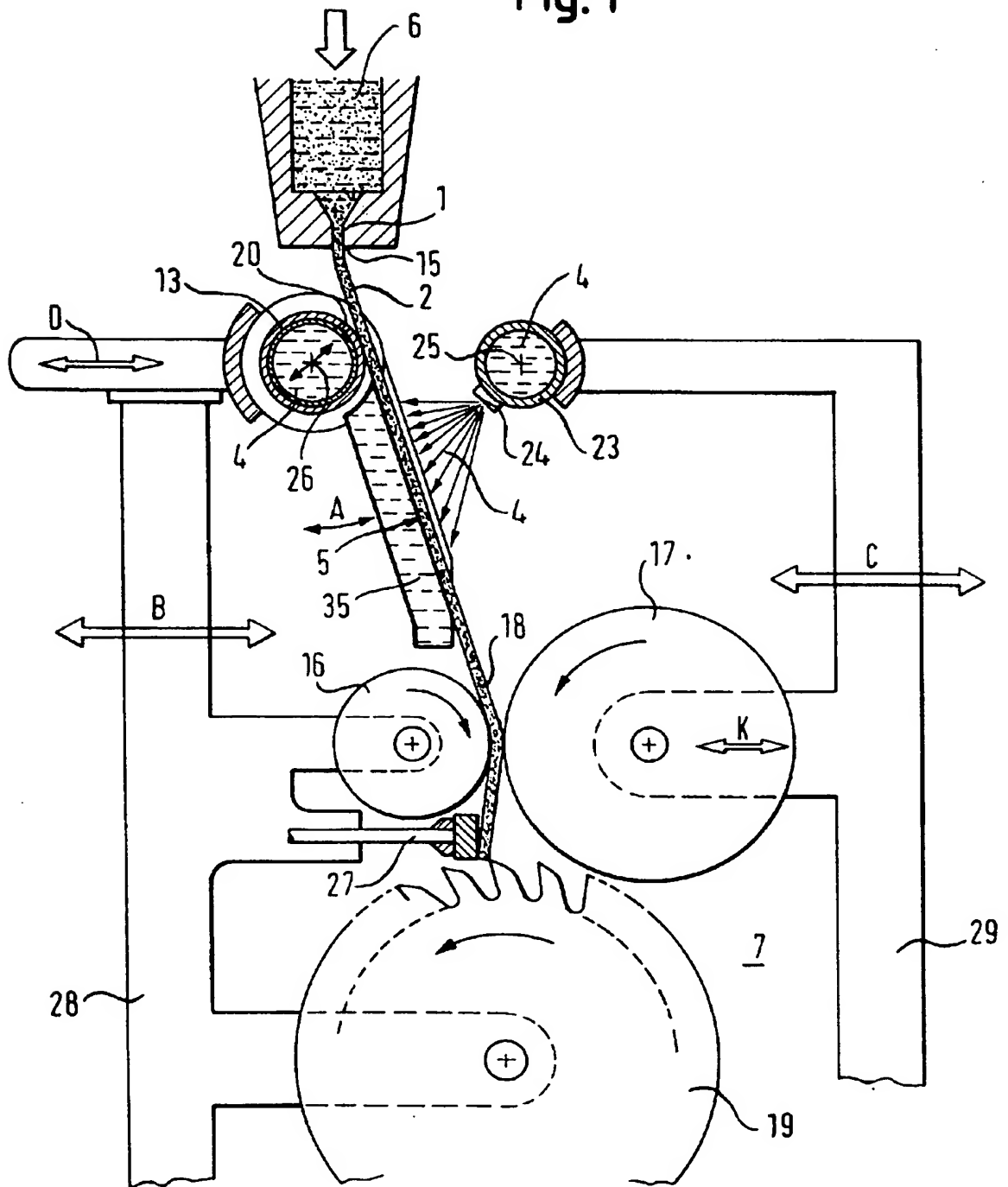
10 16. Apparatus according to Claim 15, characterized in that the feedpipe (13) has a longitudinal slot (20) for supplying the crystallization zone part with temperature-controlled medium.

15 17. Apparatus according to Claim 15 or 16, characterized in that the feedpipe (13), at each position for guiding a plastic extrudate (2), has a hole for controlling the temperature of the underside of the plastic extrudate by means of a temperature-controlled medium (4).

20 18. Apparatus according to one of the preceding claims, characterized in that a crystallization zone part (35) can pivot between an at-rest position and a working position, the at-rest position allowing the molten plastic (6) to emerge from the dies (1) in the vertical direction, and the working position feeding
25 the plastic extrudates to the pelletizing device in partially crystallized form.

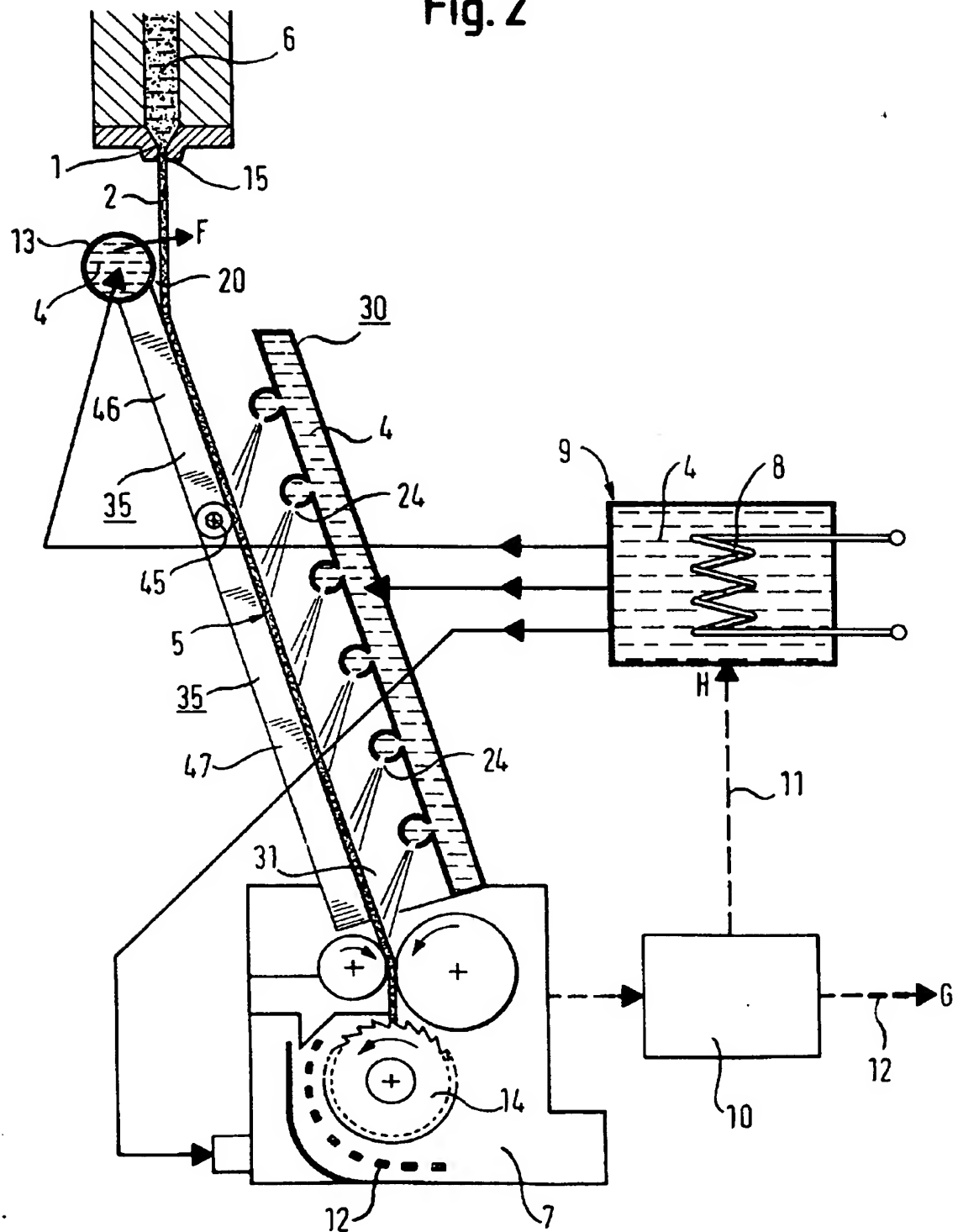
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Fig. 1



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Fig. 2



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Fig. 3a

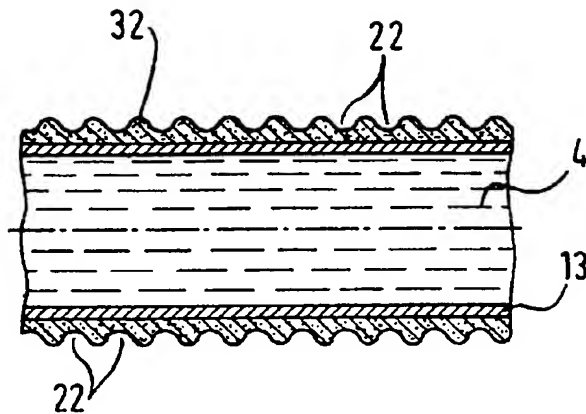


Fig. 3b

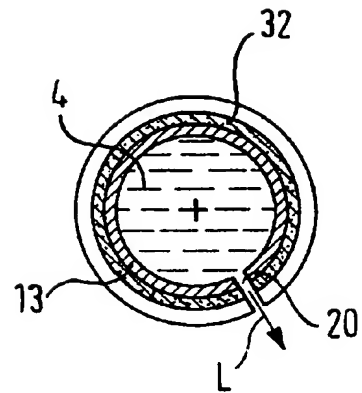


Fig. 4a

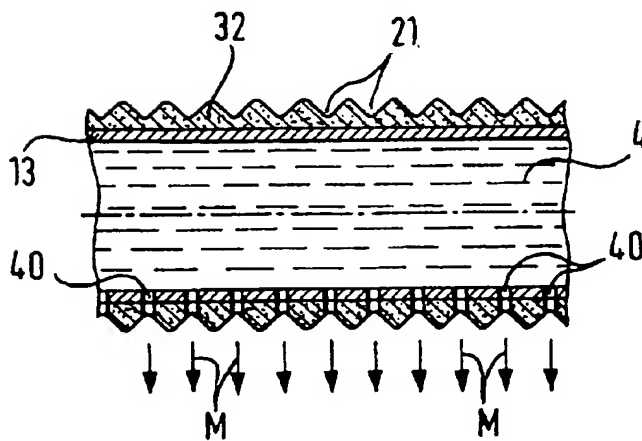


Fig. 4b

